Cucumber

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Scientific Name and Introduction: Cucumber (*Cucumis sativus* L) fruit are borne on indeterminate, tendril-bearing vines of subtropical and tropical origin (Robinson and Decker-Walters, 1997). They are members of the Cucurbitaceae family along with melons, squashes, and many other horticulturally important species. The inferior ovary has three united carpels in most cultivars. Compact, determinate cultivars have been developed for home gardeners and for mechanical, once-over mechanical harvesting (Miller and Wehner, 1989).

Quality Characteristics and Criteria: Fruit are round to oblong or narrowly cylindrical, with small tubercles (warts) and spines of trichome origin on the rind (Miller and Wehner, 1989). Dark green and firm slicing cucumbers should not be pitted or have wrinkled (ie., pinched) ends. Spine color is associated with mature fruit color and fruit netting. Fruit of white-spined cultivars are light green to yellow when mature and not netted. Black-spined fruit are orange or brown when mature and may be netted. The flesh is crisp and white, except in a few cultivars where it is pale orange.

Horticultural Maturity Indices: Fruit are harvested at various stages of development. Immature fruit are green at the edible stage, except in a few cultivars where they are white or yellow. Fruit are generally harvested immature, at sizes ranging from a 5 cm long to near full size but before the seeds are fully enlarged and hardened. Firmness and external glossiness, and formation of jelly-like material around the seeds are indicators of proper harvest maturity. Greenhouse grown parthenocarpic fruit are harvested 10 to 14 days after anthesis when they bright green (Kanellis et al., 1988). Straight, uniformly cylindrical fruit slightly tapered at both ends are of highest quality. Cucumbers are listed as non-climacteric, yet there is a burst of ethylene production that precedes a rapid loss of chlorophyll in mature fruit (Saltveit and McFeeters, 1980).

Grades, Sizes and Packaging: Grades for table or slicing cucumbers include U.S. Fancy, Extra 1, No. 1, No. 1 small, No. 1 Large and No. 2. These grades are based on uniform shape, firmness and dark green skin. Additional quality indices include size, freedom from growth or handling defects, freedom from decay, and lack of yellowing. Most fresh-market cucumbers are packed in fiberboard boxes. Pickling cucumbers are usually transported from the field to the brining facility in large field bins.

Pre-cooling Conditions: The chilling sensitivity of cucumber fruit does not preclude their pre-cooling with cold water (hydro-cooling) or air (forced-air) (Ryall and Lipton, 1979). However, even though the fruit can tolerate brief exposures to chilling temperatures, they should not be maintained at chilling temperatures for more than 6 h.

Optimum Storage Conditions: Recommended conditions for commercial storage of cucumbers are 10 to 12.5 ºC (50 to 54.5 °F) at 95% RH (Hardenburg et al., 1986). Storage-life is generally < 14 days, with visual and sensory quality rapidly declining thereafter. Chilling sensitivity limits storage temperatures to a narrow range. Storage below 10 °C (50 °F) results in chilling injury in as little as 2 to 3 days, while storage at 15 °C (59 °F) results in rapid yellowing and loss of quality.

Controlled Atmosphere (CA) Considerations: Little benefit is realized from the CA storage of cucumber fruit (Leshuk and Saltveit, 1990, Saltveit, 1997). O_2 levels of 3 to 5% delay yellowing and decay for a few days (Wang and Qi, 1997). Cucumbers tolerate CO_2 up to 10%, but the benefits are not

more than realized by reduced O_2. Parthenocarpic fruit can be stored for 1 to 3 weeks in 0.5 to 2% O_2 at 12.5 °C (54.5 °F) (Kanellis et al., 1988).

Retail Outlet Display Considerations: Chilling temperatures should be avoided. Periodic sprays of water or packaging the fruit in ventilated films can minimize water loss. High RH retards softening and pitting (a symptom of chilling injury).

Chilling Sensitivity: Cucumbers are chilling sensitive and most fruit will be injured if stored below 10 °C (50 °F) for more than 2 to 3 days. Sensitivity varies greatly with duration of exposure, temperature, cultivar, growing conditions and storage environment (Cabrera et al., 1992). CA during chilling and high RH after chilling can reduce symptom expression. Intermittent warming for 12 h to non-chilling temperatures every 2 to 3 days can reduce chilling injury (Cabrera and Saltveit, 1990). Fruit could be held at 1 to 2 °C for several days if they were immediately used following removal from storage, eg., for pickling.

Ethylene Production and Sensitivity: Cucumber fruit produce little ethylene, about 0.1 to 1.0 μL kg^{-1} h^{-1} at 20 °C (68 °F), but are very sensitive to it. Exposure to 1 to 5 μL L^{-1} ethylene accelerates yellowing and decay. Reduced O_2 and elevated CO_2 minimize the response to ethylene exposure.

Respiration Rates:

Temperature	mg CO_2 kg^{-1} h^{-1}
10 °C	23 to 29
15 °C	24 to 33
20 °C	14 to 48
25 °C	19 to 55

To get mL kg^{-1} h^{-1}, divide the mg kg^{-1} h^{-1} rate by 2.0 at 0 °C (32 °F), 1.9 at 10 °C (50 °F), and 1.8 at 20 °C (68 °F). To calculate heat production, multiply mg kg^{-1} h^{-1} by 220 to get BTU per ton per day or by 61 to get kcal per metric ton per day.

Physiological Disorders: Chilling injury is characterized by surface pitting, increase yellowing and disease susceptibility, and development of water-soaked areas of the flesh. Bruising and compression injuries are common when careful harvest and handling procedures are not followed.

Postharvest Pathology: Diseases are a significant source of postharvest loss, especially in fruit weakened by chilling injury. The many bacterial and fungal pathogens that are responsible for postharvest losses include *Alternaria* spp, *Didymella* Black Rot, *Pythium* Cottony Leak, and *Rhizopus* Soft Rot.

Quarantine Issues: None.

Suitability as Fresh-cut Product: Sliced cucumbers are available for the commercial food service industry, but not yet on the retail market.

Special Considerations: Cucumber fruit are usually treated with approved waxes or oils to reduce water loss, reduce abrasion injury and improve appearance. Surface pitting and yellowing are common defects that follow exposed to chilling temperatures and ethylene. Harvesting at the proper maturity and storing at temperatures > 10 °C (50 °F) in an ethylene-free atmosphere are necessary for high quality and market-life.

The postharvest conditions for slicing cucumbers generally apply to fruit intended for pickling. However, damage incurred during the mechanical harvesting of pickling cultivars increases their rate of respiration from 6 to 20%, their rate of water loss, and their disease susceptibility. Also, since they are commonly shipped in large field bins, prompt pre-cooling is very important to remove field heat and prevent respiratory activity from raising fruit temperature in transit. Hydro-cooling is effective for pre-cooling, but storage-life is halved because of the spread of inoculum. Sanitization of water is therefore very important. Fruit can be held at chilling temperatures for a few days if immediately used after removal from storage.

References:

Cabrera, R.M. and M.E. Saltveit. 1990. Physiological response to chilling temperatures of intermittently warmed cucumber fruit. J. Amer. Soc. Horti. Sci. 115:256-261.

Cabrera, R.M., M.E. Saltveit and K. Owens. 1992. Cucumber cultivars differ in their response to chilling temperatures. J. Amer. Soc. Horti. Sci. 117:802-807.

Hardenburg, R.E., A.E. Watada, and C.Y. Wang. 1986. The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks. USDA Agric. Handbook No. 66, 136 pp.

Kanellis, A.K., L.L. Morris, and M.E. Saltveit. 1988. Responses of parthenocarpic cucumbers to low-oxygen storage. J. Amer. Soc. Horti. Sci. 113:734-737.

Leshuk, J.A. and M.E. Saltveit. 1990. Controlled atmospheres and modified atmospheres for preservation of vegetables. In: M. Calderon (ed) Food Preservation by Modified Atmospheres. pp. 315-352.

Miller, C.H. and T.C. Wehner. 1989. Cucumbers. In: N.A.M. Eskin (ed) Quality and Preservation of Vegetables. CRC Press, Boca Raton FL, pp. 245-264.

Ryall, A.L. and W.J. Lipton. 1979. Handling, transportation and storage of fruits and vegetables. Vol. 1 Second Ed. Vegetables and Melons. AVI Pub., Westport CT, ISBN 0-87055-115-9.

Robinson, R.W. and D.S. Decker-Walters. 1997. Cucurbits. CAB Intl. Univ. Press, Cambridge.

Saltveit, M.E. 1997. A summary of CA and MA requirements and recommendations for harvested vegetables. In: 7th Intl. Contr. Atmos. Res. Conf. Vol. 4, Vegetables and Ornamentals. Univ. Calif., Davis CA, Postharv. Hort. Ser. 18:98-117.

Saltveit, M.E. and R.F. McFeeters. 1980. Polygalacturonase activity and ethylene synthesis during cucumber fruit development and maturation. Plant Physiol. 66:1019-1023.

Wang, CY, and L. Qi. 1997. Controlled atmosphere storage affects quality and chilling susceptibility of cucumbers. J. Food Quality 20:559-566.

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